
PROPULSION DIRECTORATE

Monthly Accomplishment Report March 2006



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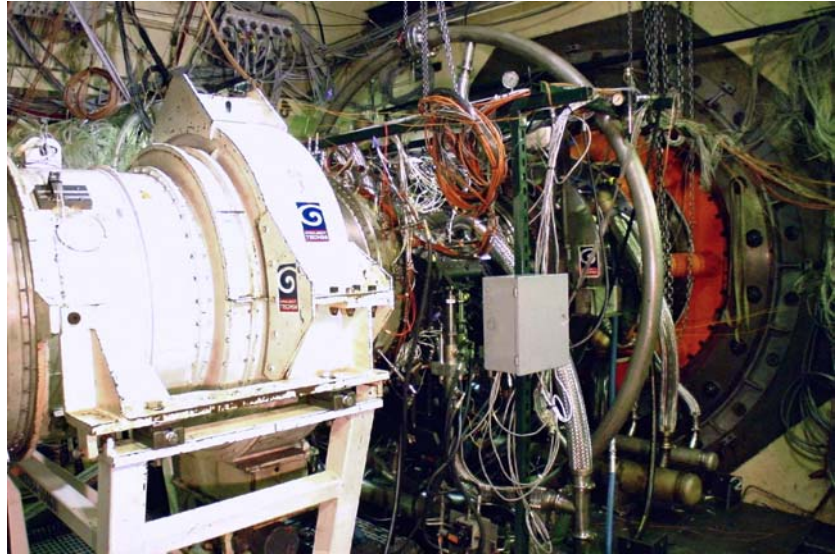
SCRAMJET ENGINE TESTING SUCCESSFULLY COMPLETED: The Propulsion Directorate's Ground Demonstration Engine #2, or GDE-2, successfully completed testing on March 31, 2006. The final tests in the series assessed the inlet performance and operability as functions of the cowl lip position and the angle of attack. Previously completed objectives included: demonstration of the closed loop fuel system utilizing JP-7 fuel; demonstration of the engine ignition sequence; verification of design tools (e.g., aerothermal, structural, control, etc.); assessment of the structural integrity of the engine; assessment of the operational characteristics of the hot gas valves; and assessment of engine thrust and performance at Mach 5. The GDE-2 is a hydrocarbon-fueled scramjet engine featuring a single integrated flow path, fuel control system, and closed-loop thermal management system. Testing was performed in NASA Langley Research Center's (LaRC) 8-foot High Temperature Tunnel in Hampton, Virginia. The ultimate objective of this test program is to develop technologies for future hypersonic propulsion systems that have application to rapid response strike and access-to-space missions. This test program was a collaborative effort between the Air Force, Pratt & Whitney Rocketdyne who built the GDE-2 engine, and NASA LaRC who provided the test facility and test support. This program is also an invaluable risk reduction effort for the scramjet engine that is to power the X-51A flight test vehicle, which is currently scheduled to fly in December 2008. (Ms. Patricia Pearce, AFRL/PRAT, (937) 255-7294)



The GDE-2 undergoes testing at NASA Langley Research Center

TESTING OF GE VAATE CORE COMPRESSOR UNDERWAY: Testing of General Electric's (GE) Long Range Strike (LRS) Versatile Affordable Advanced Turbine Engines (VAATE) core compressor began in the Propulsion Directorate's Compressor Research Facility (CRF) on March 28, 2006. The objectives of this test program are to further develop the front three stages

of the dual-use core compressor to increase part speed efficiency, investigate concepts that mitigate blade row interaction losses without requiring large axial spacing, and validate and improve time-accurate CFD design tools. To accomplish this, five different builds will be tested. Mechanical checkout of build one was quickly completed, and stator optimization and aero mapping were subsequently completed on April 12, 2006. Thus far the rig has accumulated 25 hours of test



GE's Long Range Strike VAATE core compressor mounted in the test cell

time, and 350 steady state data points have been acquired. Build one has a new inlet guide vane (IGV) and stator 1 compared to the baseline previously tested by GE at their Lynn, Massachusetts, facility. CRF data has demonstrated a significant efficiency improvement at 70% and 80% corrected speeds at all throttle conditions while maintaining the low power stall margin. At high power, similar levels of flow, efficiency, and stall margin were maintained compared to the baseline. These improvements help enable the GE LRS engine to meet its goal factors for thrust-to-weight, thrust specific fuel consumption (TSFC), and development cost. (Dr. Steve Gorrell, AFRL/PRTF, (937) 255-7344)

AFFLIATE SOCIETIES COUNCIL PRESENTS AWARDS: The [Affiliate Societies Council of Dayton](#) held its 47th Annual Outstanding Engineers & Scientists Awards Banquet on March 2, 2006 at Sinclair Community College in Dayton, Ohio. These prestigious awards recognize significant contributions to the fields of science and engineering by those who live and work in the Miami Valley. Awards are given in five categories: Education; Research; Technical Leadership; Engineering Design and Development; and Manufacturing, Production, and Quality Control. Two of this year's thirteen honorees were recognized for their work with AFRL's Propulsion Directorate. Dr. Robert Hancock, Chief of AFRL/PR's [Combustion Branch](#) (AFRL/PRTC), was honored in the Technical Leadership category. Dr. Hancock was recognized for his dynamic leadership of a group that is responsible for Air Force research on combustors, afterburners, pulsed detonation engines (PDEs), optical diagnostics, and emissions sensors. Dr. Sivaram Gogineni, Vice President of [Innovative Scientific Solutions, Inc.](#) and an on-site contractor with AFRL/PR, was honored in the Research category. Dr. Gogineni is a world-renowned expert in the design, development, and application of state-of-the-art laser- and optical-based diagnostics. Established in 1969, the Affiliate Societies Council consists of about 50 engineering and science-related professional societies whose combined membership in the Dayton area exceeds 15,000. (Mr. Jeff Pearce, AFRL/PRA (UTC), (937) 255-5015)



Dr. Robert Hancock (L) and Dr. Sivaram Gogineni (R) were recently honored by The Affiliate Societies Council of Dayton

MR. STRICKER HONORED FOR TURBINE ENGINE TECHNOLOGY LEADERSHIP:

The Propulsion Directorate's Mr. Jeffrey M. Stricker was presented with the Meritorious Civilian Service Award in a ceremony on March 10, 2006. Mr. Stricker was honored for his leadership and technical excellence as the Chief of the Engine Integration and Assessment Branch (AFRL/PRTA) and as Chief Engineer for the Propulsion Directorate's Turbine Engine Division from October 2001 to September 2005. Mr. Stricker has done a superb job in leading the Air Force's turbine engine Science and Technology (S&T) program to meet the needs of legacy, pipeline, and future weapon systems. As Chief of AFRL/PRTA, he managed 18 government employees and contractor support personnel, and executed a budget of \$3 million per year to advance the state of the art in turbine engine analysis, controls, thermal management, and exhaust system technology. He led his branch through the arduous



Mr. Jeff Stricker recently received the Meritorious Civilian Service Award

task of defining the very essence of the turbine engine development strategy embodied in the Versatile Affordable Advanced Turbine Engines (VAATE) Program. He was also a key player in developing the strategy for the successful completion of the Integrated High Performance Turbine Engine Technology (IHPTET) Program - a program with a remarkable track record of accomplishments. Mr. Stricker is also a visionary in the turbine engine arena, and he transformed the turbine engine development approach to align with the new Air Force Concept of Operations construct adopted in 2002. Mr. Stricker's leadership, technical competence, and eagerness to accept responsibility make him truly deserving of this recognition. (LtCol Doug Decker, AFRL/PRT, (937) 255-4100)

PR PARTICIPATION BOLSTERS AIAA MEETING: The 31st American Institute of Aeronautics and Astronautics (AIAA) [Dayton-Cincinnati Aerospace Sciences Meeting](#) (DCASS) was held in Dayton, Ohio, on March 7, 2006. This event is designed to foster technical



AFRL/PR's Dr. Marc Polanka served as the Executive Co-Chair of the DCASS Meeting as well as co-chair for the Technical Program Committee

interchange between the local academic, government, and industry communities. AFRL's Propulsion Directorate continued its long-standing tradition of actively participating in this meeting - a practice which has significantly contributed to the meeting's lasting success. AFRL/PR personnel (including on-site contractors) chaired or co-chaired 6 of the 10 committees assembled to execute the meeting. Notably, AFRL/PR's Dr. Marc Polanka served as the Executive Co-Chair of the DCASS Meeting as well as co-chair for the Technical Program Committee. The meeting featured 45 technical sessions covering a wide variety of technical disciplines, and AFRL/PR personnel chaired 16 of these sessions. Furthermore, AFRL/PR personnel actively participated in the meeting, co-authoring nearly 40 of the more than 200 papers presented. (Mr. Jeff Pearce, AFRL/PRA (UTC), (937) 255-5015)

MICROPROPULSION ARTICLE FEATURED BY TECHNICAL JOURNAL:

A recent article by the Propulsion Directorate's Dr. Andrew Ketsdever* in collaboration with Messrs. Riki H. Lee and Taylor

C. Lilly of the University of Southern California, is being showcased by the *Journal of Micromechanics and Microengineering* (JMM). [JMM Highlights of 2005](#) features 24 articles that provide a taste of the content published in the journal. These 24 articles showcase top recent contributions and, according to the referees, were selected for being the most downloaded or of the highest quality. The paper by Ketsdever, Lee, and Lilly[†] is titled "Performance Testing of a

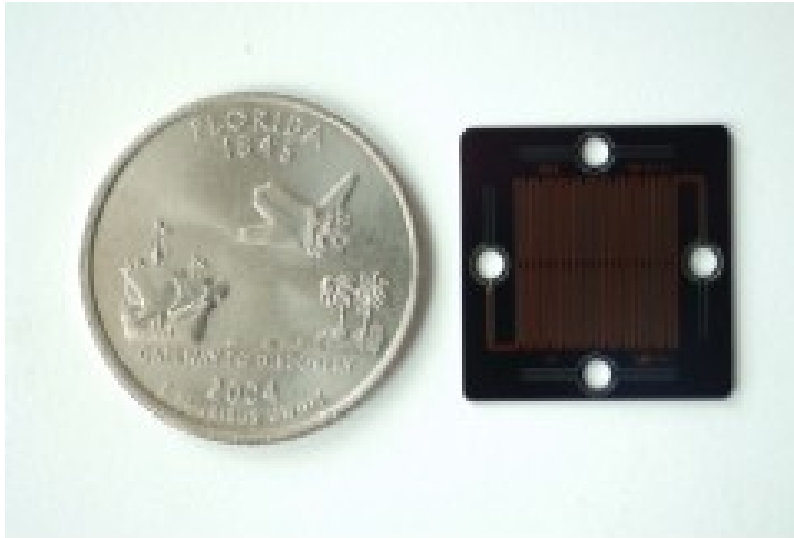
* Dr. Ketsdever is on temporary assignment as a visiting professor at the US Air Force Academy.

[†] Andrew D. Ketsdever, Riki H. Lee, and Taylor C. Lilly, "Performance Testing of a Microfabricated Propulsion System for Nanosatellite Applications," *Journal of Micromechanics and Microengineering*, Vol. 15, No. 12 (December 2005), pp. 2254-2263.

Microfabricated Propulsion System for Nanosatellite Applications.” The article describes the fabrication and testing of a Free Molecule Micro-Resistojet (FMMR), an electrothermal propulsion system designed for on-orbit maneuvers of nanosatellites. The version of the FMMR discussed in the article was specifically developed to provide attitude control for an upcoming university nanosatellite mission. (Dr. Andrew Ketsdever, USAFA/DFAS, (719) 333-1693)



Dr. Andrew Ketsdever



MEMS fabricated FMMR heater chip